



Comprehensive Energy Audit For Chuathbaluk Water Treatment Plant



Prepared For
City of Chuathbaluk

June 12, 2012

Prepared By:

**ANTHC-DEHE
1901 Bragaw Suite, Suite 200
Anchorage, Alaska 99508**

Table of Contents

| | |
|--|----|
| 1. EXECUTIVE SUMMARY | 3 |
| 2. AUDIT AND ANALYSIS BACKGROUND | 5 |
| 2.1 Program Description | 5 |
| 2.2 Audit Description | 5 |
| 2.3. Method of Analysis | 6 |
| 2.4 Limitations of Study | 7 |
| 3. Chuathbaluk Water Treatment Plant..... | 8 |
| 3.1. Building Description | 8 |
| 3.2 Predicted Energy Use..... | 10 |
| 3.2.1 Energy Usage / Tariffs | 10 |
| 3.2.2 Energy Use Index (EUI)..... | 13 |
| 3.3 AkWarm© Building Simulation..... | 14 |
| 4. ENERGY COST SAVING MEASURES..... | 15 |
| 4.1 Summary of Results | 15 |
| 4.2 Interactive Effects of Projects..... | 16 |
| 5. ENERGY EFFICIENCY ACTION PLAN | 18 |
| Appendix A – Listing of Energy Conservation and Renewable Energy Websites..... | 19 |

PREFACE

The Energy Projects Group at the Alaska Native Tribal Health Consortium (ANTHC) prepared this document for the City of Chuathbaluk. The authors of this report are Carl Remley, Certified Energy Auditor (CEA) and Gavin Dixon.

The purpose of this report is to provide a comprehensive document that summarizes the findings and analysis that resulted from an energy audit conducted over the past couple months by the Energy Projects Group of ANTHC. This report analyzes historical energy use and identifies costs and savings of recommended energy efficiency measures. Discussions of site specific concerns and an Energy Efficiency Action Plan are also included in this report.

ACKNOWLEDGMENTS

The Energy Projects Group gratefully acknowledges the assistance of Bill Nesbit and Carl Nesbit, Water Plant Operators for the City of Chuathbaluk.

1. EXECUTIVE SUMMARY

This report was prepared for the City of Chuathbaluk. The scope of the audit focused on Chuathbaluk Water Treatment Plant. The scope of this report is a comprehensive energy study, which included an analysis of building shell, interior and exterior lighting systems, HVAC systems, and plug loads.

Based on electricity and fuel oil prices in effect at the time of the audit, the annual predicted energy costs for the buildings analyzed are \$10,442 for Electricity and \$12,479 for #1 Oil. The total energy costs are \$22,921 per year.

It should be noted that facility did not receive the power cost equalization subsidy from the state of Alaska last year. However, the electric company charged the facility the PCE rate of \$0.46/kwh. Middle Kuskokwim Electrical Cooperative should consider applying for power cost equalization funding for this facility.

Table 1.1 below summarizes the energy efficiency measures analyzed for the Chuathbaluk Water Treatment Plant. Listed are the estimates of the annual savings, installed costs, and two different financial measures of investment return.

| Table 1.1 | | | | | | |
|---|---------------------------------|--|-----------------------|----------------|---|-------------------------------------|
| PRIORITY LIST – ENERGY EFFICIENCY MEASURES | | | | | | |
| Rank | Feature | Improvement Description | Annual Energy Savings | Installed Cost | Savings to Investment Ratio, SIR ¹ | Simple Payback (Years) ² |
| 1 | Setback Thermostat: Water Plant | Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space. | \$358 | \$200 | 24.29 | 0.6 |
| 2 | HVAC And DHW | Clean and tune boilers, add in two primary loops on the boilers to control them individually and isolate one boiler. | \$849 | \$5,000 | 2.56 | 5.9 |

Table 1.1
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

| Rank | Feature | Improvement Description | Annual Energy Savings | Installed Cost | Savings to Investment Ratio, SIR ¹ | Simple Payback (Years) ² |
|----------------------------|-----------------------------------|--|-----------------------|------------------|---|-------------------------------------|
| 3 | Circulation Loops | Loop Temperatures above 40 degrees are not required. Buried circulating mains are in good condition and consequently have very little heat loss, there is negligible advantage heating these lines to 48 degrees which comes at a substantial cost. Loop two requires a chlorine makeup injection port; currently chlorine residual is being controlled by dumping 2,000 gallons of water/week to waste. With these savings and the implementation of recovered heat from the MKEC power plant, heating fuel requirements should be reduced to those of facility heat. | \$5,370 | \$105,000 | 1.09 | 19.6 |
| 4 | Water Storage Tank | The water storage tank receives water from the well pump and heats it to 50 degrees. The turnover in the tank is very high, and the thermal storage capacity of the water is also high, so the tank should only be heated to 40 degrees. Implement waste heat from the MKEC power plant to heat storage tank. | \$1,981 | \$40,000 | 1.05 | 20.2 |
| 5 | Setback Thermostat: Chemical Room | Implement a Heating Temperature Unoccupied Setback to 45.0 deg F for the Chemical Room space. | \$38 | \$500 | 1.02 | 13.2 |
| TOTAL, all measures | | | \$8,597 | \$150,700 | 1.16 | 17.5 |

Table Notes:

¹ Savings to Investment Ratio (SIR) is a life-cycle cost measure calculated by dividing the total savings over the life of a project (expressed in today's dollars) by its investment costs. The SIR is an indication of the profitability of a measure; the higher the SIR, the more profitable the project. An SIR greater than 1.0 indicates a cost-effective project (i.e. more savings than cost). Remember that this profitability is based on the position of that Energy Efficiency Measure (EEM) in the overall list and assumes that the measures above it are implemented first.

² Simple Payback (SP) is a measure of the length of time required for the savings from an EEM to payback the investment cost, not counting interest on the investment and any future changes in energy prices. It is calculated by dividing the investment cost by the expected first-year savings of the EEM.

With all of these energy efficiency measures in place, the annual utility cost can be reduced by \$8,597 per year, or 37.5% of the buildings' total energy costs. These measures are estimated to cost \$150,700, for an overall simple payback period of 17.5 years.

Table 1.2 below is a breakdown of the annual energy cost across various energy end use types, such as Space Heating and Water Heating. The first row in the table shows the breakdown for the building as it is now. The second row shows the expected breakdown of energy cost for the building assuming all of the retrofits in this report are implemented. Finally, the last row shows the annual energy savings that will be achieved from the retrofits.

| Table 1.2 Annual Energy Cost Estimate | | | | | | | | | | |
|--|----------------------|----------------------|----------------------|-----------------|----------------------|-------------------------|---------------------------|--------------------------|-------------------------|-------------------|
| Description | Space Heating | Space Cooling | Water Heating | Lighting | Refrigeration | Other Electrical | Water Storage Tank | Circulation Loops | Ventilation Fans | Total Cost |
| Existing Building | \$2,970 | \$0 | \$67 | \$104 | \$0 | \$2,430 | \$2,959 | \$14,391 | \$0 | \$22,921 |
| With All Proposed Retrofits | \$1,724 | \$0 | \$67 | \$104 | \$0 | \$2,430 | \$978 | \$9,021 | \$0 | \$14,324 |
| SAVINGS | \$1,246 | \$0 | \$0 | \$0 | \$0 | \$0 | \$1,981 | \$5,370 | \$0 | \$8,597 |

2. AUDIT AND ANALYSIS BACKGROUND

2.1 Program Description

This audit included services to identify, develop, and evaluate energy efficiency measures at the Chuathbaluk Water Treatment Plant. The scope of this project included evaluating building shell, lighting and other electrical systems, and HVAC equipment, motors and pumps. Measures were analyzed based on life-cycle-cost techniques, which include the initial cost of the equipment, life of the equipment, annual energy cost, annual maintenance cost, and a discount rate of 3.0%/year in excess of general inflation.

2.2 Audit Description

Preliminary audit information was gathered in preparation for the site survey. The site survey provides critical information in deciphering where energy is used and what opportunities exist within a building. The entire site was surveyed to inventory the following to gain an understanding of how each building operates:

- Building envelope (roof, windows, etc.)
- Heating, ventilation, and air conditioning equipment (HVAC)
- Lighting systems and controls
- Building-specific equipment

The building site visit was performed to survey all major building components and systems. The site visit included detailed inspection of energy consuming components. Summary of building occupancy schedules, operating and maintenance practices, and energy management programs provided by the building manager were collected along with the system and components to determine a more accurate impact on energy consumption.

Details collected from Chuathbaluk Water Treatment Plant enable a model of the building's energy usage to be developed, highlighting the building's total energy consumption, energy consumption by specific building component, and equivalent energy cost. The analysis involves distinguishing the different fuels used on site, and analyzing their consumption in different activity areas of the building.

Chuathbaluk Water Treatment Plant is classified as being made up of the following activity areas:

- 1) Water Plant: 600 square feet
- 2) Chemical Room: 21 square feet

In addition, the methodology involves taking into account a wide range of factors specific to the building. These factors are used in the construction of the model of energy used. The factors include:

- Occupancy hours
- Local climate conditions
- Prices paid for energy

2.3. Method of Analysis

Data collected was processed using AkWarm© Energy Use Software to estimate energy savings for each of the proposed energy efficiency measures (EEMs). The recommendations focus on the building envelope; HVAC; lighting, plug load, and other electrical improvements; and motor and pump systems that will reduce annual energy consumption.

EEMs are evaluated based on building use and processes, local climate conditions, building construction type, function, operational schedule, existing conditions, and foreseen future plans. Energy savings are calculated based on industry standard methods and engineering estimations.

Our analysis provides a number of tools for assessing the cost effectiveness of various improvement options. These tools utilize **Life-Cycle Costing**, which is defined in this context as a method of cost analysis that estimates the total cost of a project over the period of time that includes both the construction cost and ongoing maintenance and operating costs.

Savings to Investment Ratio (SIR) = Savings divided by Investment

Savings includes the total discounted dollar savings considered over the life of the improvement. When these savings are added up, changes in future fuel prices as projected by the Department of Energy are included. Future savings are discounted to the present to

account for the time-value of money (i.e. money's ability to earn interest over time). The **Investment** in the SIR calculation includes the labor and materials required to install the measure. An SIR value of at least 1.0 indicates that the project is cost-effective—total savings exceed the investment costs.

Simple payback is a cost analysis method whereby the investment cost of a project is divided by the first year's savings of the project to give the number of years required to recover the cost of the investment. This may be compared to the expected time before replacement of the system or component will be required. For example, if a boiler costs \$12,000 and results in a savings of \$1,000 in the first year, the payback time is 12 years. If the boiler has an expected life to replacement of 10 years, it would not be financially viable to make the investment since the payback period of 12 years is greater than the project life.

The Simple Payback calculation does not consider likely increases in future annual savings due to energy price increases. As an offsetting simplification, simple payback does not consider the need to earn interest on the investment (i.e. it does not consider the time-value of money). Because of these simplifications, the SIR figure is considered to be a better financial investment indicator than the Simple Payback measure.

Measures are implemented in order of cost-effectiveness. The program first calculates individual SIRs, and ranks all measures by SIR, higher SIRs at the top of the list. An individual measure must have an individual $SIR \geq 1$ to make the cut. Next the building is modified and re-simulated with the highest ranked measure included. Now all remaining measures are re-evaluated and ranked, and the next most cost-effective measure is implemented. AkWarm goes through this iterative process until all appropriate measures have been evaluated and installed.

It is important to note that the savings for each recommendation is calculated based on implementing the most cost effective measure first, and then cycling through the list to find the next most cost effective measure. Implementation of more than one EEM often affects the savings of other EEMs. The savings may in some cases be relatively higher if an individual EEM is implemented in lieu of multiple recommended EEMs. For example implementing a reduced operating schedule for inefficient lighting will result in relatively high savings. Implementing a reduced operating schedule for newly installed efficient lighting will result in lower relative savings, because the efficient lighting system uses less energy during each hour of operation. If multiple EEM's are recommended to be implemented, AkWarm calculates the combined savings appropriately.

Cost savings are calculated based on estimated initial costs for each measure. Installation costs include labor and equipment to estimate the full up-front investment required to implement a change. Costs are derived from Means Cost Data, industry publications, and local contractors and equipment suppliers.

2.4 Limitations of Study

All results are dependent on the quality of input data provided, and can only act as an approximation. In some instances, several methods may achieve the identified savings. This

report is not intended as a final design document. The design professional or other persons following the recommendations shall accept responsibility and liability for the results.

3. Chuathbaluk Water Treatment Plant

3.1. Building Description

The 621 square foot Chuathbaluk Water Treatment Plant was constructed in 2004, with a normal occupancy of 2 people. The number of hours of operation for this building average 1 hour per day, considering all seven days of the week.

The Water Plant is a new circulating distribution system designed by Summit. It has a 14,000 gallon storage tank, a 230 foot well, and three mostly buried circulating lines serves about 35 total connections. The lines are buried 4-6 feet deep, and are heated to 48 degrees currently.

Loop 1 has 4,481 linear feet of buried arctic pipes and 16 houses, several community buildings, and uses about 52,000 gallons of water per month.

Loop 2 has 4,021 linear feet of buried arctic pipe and services two houses, a storage and runs past the power plant. This loop has problems maintaining chlorine residual numbers due to the low water usage rate.

Loop 3 is 8,044 linear feet of buried arctic pipe with 500 feet exposed. The line serves two homes and the school, and uses an average of 28,000 gallons of water per month.

Lines have a glycol heat trace that isn't used, as the lines have a heat add system and low heat loss. The gravity sewer mains drain to a single lift station that pumps to the community's lagoon.

Description of Building Shell

The exterior walls are constructed with structurally insulated panels with 5.5 inches of polyurethane insulation.

The roof of the building is a cold roof with 5.5 inches of polyurethane insulation.

The floor of the building is built on grade with a slab foundation and 2 inches of insulation covering the exterior of the concrete pad.

The facility has no exterior windows.

Doors are metal with a urethane core and a metal edge.

Description of Heating Plants

The Heating Plants used in the building are:

Weil McLain Gold Oil #1

| | |
|--------------------------|----------------|
| Fuel Type: | #1 Oil |
| Input Rating: | 112,200 BTU/hr |
| Steady State Efficiency: | 80 % |
| Idle Loss: | 1.5 % |
| Heat Distribution Type: | Glycol |
| Boiler Operation: | Oct - Jun |

Weil McLain Gold Oil #2

| | |
|--------------------------|----------------|
| Fuel Type: | #1 Oil |
| Input Rating: | 112,200 BTU/hr |
| Steady State Efficiency: | 80 % |
| Idle Loss: | 1.5 % |
| Heat Distribution Type: | Glycol |
| Boiler Operation: | Oct - Jun |

Electric Hot Water Heater

| | |
|--------------------------|-------------|
| Fuel Type: | Electricity |
| Input Rating: | 0 BTU/hr |
| Steady State Efficiency: | 100 % |
| Idle Loss: | 0 % |
| Heat Distribution Type: | Water |
| Boiler Operation: | All Year |

Space Heating Distribution Systems

Heat is supplied to the facility by a single unit heater in the main room, and a smaller one in the chlorine room. The unit heater rarely comes on; the facility is in reality heated primarily by jacket losses off the boilers and heat given off by the various circulation pumps.

Domestic Hot Water System

A 2.6 gallon electric hot water heater supplies the hot water to the facility, which is only used to wash hands occasionally.

Heat Recovery Information

There is currently no heat recovery system in place in the facility, Chuathbaluk serves as a prime opportunity for recovered heat utilization, more details are available in the retrofit section.

Lighting

Lighting in the facility is made up of seven T8 electronic ballast fixtures with three 32 watt four foot bulbs each.

Plug Loads

There are no regular plug loads in the facility. Various tools and equipment are occasionally used or charged.

Major Equipment

The well pump is a five horsepower pump with a Franklin Electric motor that runs about 2 hours a day pumping at around 31.8 gallons per minute.

A pair of three horsepower G+L Model NPE 1 pressure pumps supply pressure to the system by alternating and run about 8% of the time.

The water storage tank is circulated by a Grundfos UPS 15-42SF circulation pump set to setting three.

The water circulation pumps for each loop are Grundfos UPS40-160F pumps. Each loop has two pumps piped in parallel with only one pump currently running.

3.2 Predicted Energy Use

3.2.1 Energy Usage / Tariffs

The electric usage profile charts (below) represents the predicted electrical usage for the building. If actual electricity usage records were available, the model used to predict usage was calibrated to approximately match actual usage. The electric utility measures consumption in kilowatt-hours (kWh) and maximum demand in kilowatts (kW). One kWh usage is equivalent to 1,000 watts running for one hour.

The fuel oil usage profile shows the fuel oil usage for the building. Fuel oil consumption is measured in gallons. One gallon of #1 Fuel Oil provides approximately 132,000 BTUs of energy.

The following is a list of the utility companies providing energy to the building and the class of service provided:

Electricity: Middle Kuskokwim Electric Coop - Commercial - Sm

The average cost for each type of fuel used in this building is shown below in Table 3.1. This figure includes all surcharges, subsidies, and utility customer charges:

| Table 3.1 – Average Energy Cost | |
|--|----------------------------|
| Description | Average Energy Cost |
| Electricity | \$ 0.46/kWh |
| #1 Oil | \$ 6.80/gallons |

3.2.1.1 Total Energy Use and Cost Breakdown

At current rates, City of Chuathbaluk pays approximately \$22,921 annually for electricity and other fuel costs for the Chuathbaluk Water Treatment Plant.

Figure 3.1 below reflects the estimated distribution of costs across the primary end uses of energy based on the AkWarm© computer simulation. Comparing the “Retrofit” bar in the figure to the “Existing” bar shows the potential savings from implementing all of the energy efficiency measures shown in this report.

Figure 3.1
Annual Energy Costs by End Use

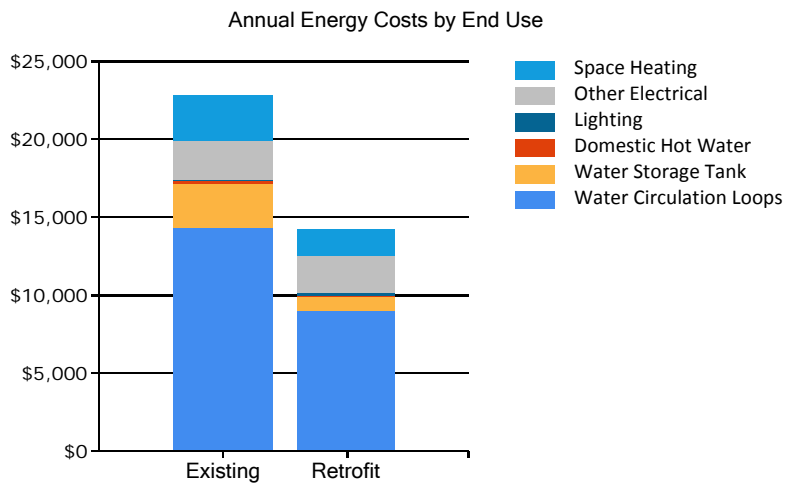


Figure 3.2 below shows how the annual energy cost of the building splits between the different fuels used by the building. The “Existing” bar shows the breakdown for the building as it is now; the “Retrofit” bar shows the predicted costs if all of the energy efficiency measures in this report are implemented.

Figure 3.2
Annual Energy Costs by Fuel Type

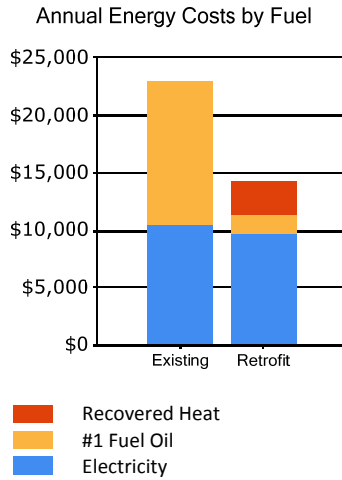
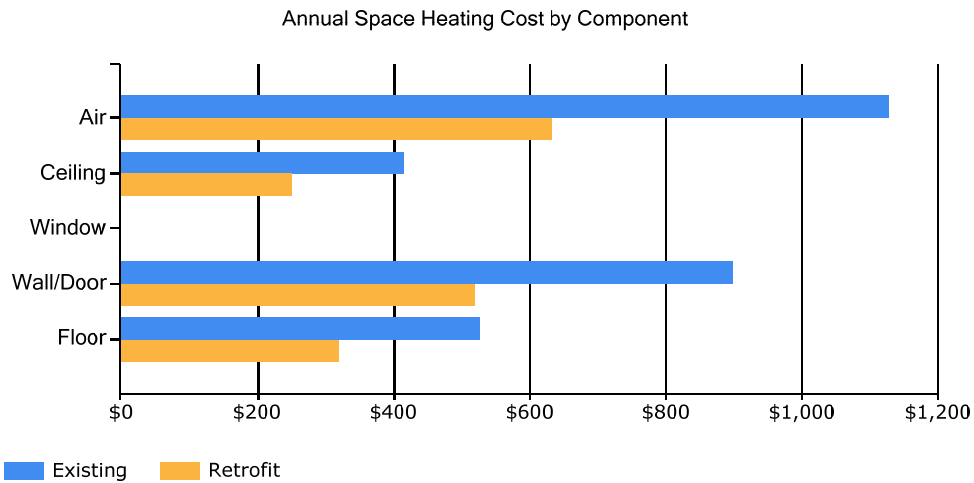


Figure 3.3 below addresses only Space Heating costs. The figure shows how each heat loss component contributes to those costs; for example, the figure shows how much annual space heating cost is caused by the heat loss through the Walls/Doors. For each component, the space heating cost for the Existing building is shown (blue bar) and the space heating cost assuming all retrofits are implemented (yellow bar) are shown.

Figure 3.3
Annual Space Heating Cost by Component



The tables below show AkWarm’s estimate of the monthly fuel use for each of the fuels used in the building. For each fuel, the fuel use is broken down across the energy end uses. Note, in the tables below “DHW” refers to Domestic Hot Water heating.

| Electrical Consumption (kWh) | | | | | | | | | | | | |
|------------------------------|------|------|------|------|------|------|-----|-----|------|------|------|------|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Lighting | 19 | 18 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| Other_Electrical | 448 | 409 | 448 | 434 | 448 | 434 | 448 | 448 | 434 | 448 | 434 | 448 |
| Water Storage Tank | 63 | 58 | 63 | 61 | 63 | 61 | 0 | 0 | 0 | 63 | 61 | 63 |
| Circulation Loops | 1669 | 1521 | 1669 | 1615 | 1669 | 1615 | 0 | 0 | 0 | 1669 | 1615 | 1669 |
| DHW | 12 | 11 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| Space_Heating | 228 | 207 | 226 | 216 | 223 | 7 | 0 | 0 | 1 | 224 | 219 | 228 |

| Fuel Oil #1 Consumption (Gallons) | | | | | | | | | | | | |
|-----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
| Water Storage Tank | 45 | 41 | 45 | 44 | 45 | 44 | 0 | 0 | 0 | 45 | 44 | 45 |
| Circulation Loops | 127 | 116 | 127 | 123 | 127 | 123 | 0 | 0 | 0 | 127 | 123 | 127 |
| Space_Heating | 58 | 46 | 39 | 19 | 19 | 3 | 3 | 3 | 6 | 22 | 40 | 58 |

3.2.2 Energy Use Index (EUI)

Energy Use Index (EUI) is a measure of a building’s annual energy utilization per square foot of building. This calculation is completed by converting all utility usage consumed by a building for one year, to British Thermal Units (Btu) or kBtu, and dividing this number by the building square footage. EUI is a good measure of a building’s energy use and is utilized regularly for comparison of energy performance for similar building types. The Oak Ridge National Laboratory (ORNL) Buildings Technology Center under a contract with the U.S. Department of Energy maintains a Benchmarking Building Energy Performance Program. The ORNL website determines how a building’s energy use compares with similar facilities throughout the U.S. and in a specific region or state.

Source use differs from site usage when comparing a building’s energy consumption with the national average. Site energy use is the energy consumed by the building at the building site only. Source energy use includes the site energy use as well as all of the losses to create and distribute the energy to the building. Source energy represents the total amount of raw fuel that is required to operate the building. It incorporates all transmission, delivery, and production losses, which allows for a complete assessment of energy efficiency in a building. The type of utility purchased has a substantial impact on the source energy use of a building. The EPA has determined that source energy is the most comparable unit for evaluation purposes and overall global impact. Both the site and source EUI ratings for the building are provided to understand and compare the differences in energy use.

The site and source EUIs for this building are calculated as follows. (See Table 3.4 for details):

$$\text{Building Site EUI} = \frac{(\text{Electric Usage in kBtu} + \text{Fuel Oil Usage in kBtu})}{\text{Building Square Footage}}$$

$$\text{Building Source EUI} = \frac{(\text{Electric Usage in kBtu} \times \text{SS Ratio} + \text{Fuel Oil Usage in kBtu} \times \text{SS Ratio})}{\text{Building Square Footage}}$$

where “SS Ratio” is the Source Energy to Site Energy ratio for the particular fuel.

Table 3.4
Chuathbaluk Water Treatment Plant EUI Calculations

| Energy Type | Building Fuel Use per Year | Site Energy Use per Year, kBTU | Source/Site Ratio | Source Energy Use per Year, kBTU |
|--|-----------------------------------|---------------------------------------|--------------------------|---|
| Electricity | 22,701 kWh | 77,477 | 3.340 | 258,775 |
| #1 Oil | 1,835 gallons | 242,240 | 1.010 | 244,662 |
| Total | | 319,717 | | 503,437 |
| BUILDING AREA 621 Square Feet | | | | |
| BUILDING SITE EUI 515 kBTU/Ft ² /Yr | | | | |
| BUILDING SOURCE EUI 811 kBTU/Ft ² /Yr | | | | |
| * Site - Source Ratio data is provided by the Energy Star Performance Rating Methodology for Incorporating Source Energy Use document issued March 2011. | | | | |

3.3 AkWarm© Building Simulation

An accurate model of the building performance can be created by simulating the thermal performance of the walls, roof, windows and floors of the building. The HVAC system and central plant are modeled as well, accounting for the outside air ventilation required by the building and the heat recovery equipment in place.

The model uses local weather data and is trued up to historical energy use to ensure its accuracy. The model can be used now and in the future to measure the utility bill impact of all types of energy projects, including improving building insulation, modifying glazing, changing air handler schedules, increasing heat recovery, installing high efficiency boilers, using variable air volume air handlers, adjusting outside air ventilation and adding cogeneration systems.

For the purposes of this study, the Chuathbaluk Water Treatment Plant was modeled using AkWarm© energy use software to establish a baseline space heating and cooling energy usage. Climate data from Chuathbaluk was used for analysis. From this, the model was calibrated to predict the impact of theoretical energy savings measures. Once annual energy savings from a particular measure were predicted and the initial capital cost was estimated, payback scenarios were approximated. Equipment cost estimate calculations are provided in Appendix D.

Limitations of AkWarm© Models

- The model is based on typical mean year weather data for Chuathbaluk. This data represents the average ambient weather profile as observed over approximately 30 years. As such, the gas and electric profiles generated will not likely compare perfectly with actual energy billing information from any single year. This is especially true for years with extreme warm or cold periods, or even years with unexpectedly moderate weather.
- The heating and cooling load model is a simple two-zone model consisting of the building's core interior spaces and the building's perimeter spaces. This simplified approach loses accuracy for buildings that have large variations in cooling/heating loads across different parts of the building.
- The model does not model HVAC systems that simultaneously provide both heating and cooling to the same building space (typically done as a means of providing temperature control in the space).

The energy balances shown in Section 3.1 were derived from the output generated by the AkWarm© simulations.

4. ENERGY COST SAVING MEASURES

4.1 Summary of Results

The energy saving measures are summarized in Table 4.1. Please refer to the individual measure descriptions later in this report for more detail. Calculations and cost estimates for analyzed measures are provided in Appendix C.

| Table 4.1 Chuathbaluk Water Treatment Plant, Chuathbaluk, Alaska PRIORITY LIST – ENERGY EFFICIENCY MEASURES | | | | | | |
|--|---------------------------------|--|-----------------------|----------------|----------------------------------|------------------------|
| Rank | Feature | Improvement Description | Annual Energy Savings | Installed Cost | Savings to Investment Ratio, SIR | Simple Payback (Years) |
| 1 | Setback Thermostat: Water Plant | Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space. | \$358 | \$200 | 24.29 | 0.6 |
| 2 | HVAC And DHW | Clean and tune boilers, add in two primary loops on the boilers to control them individually and isolate one boiler. | \$849 | \$5,000 | 2.56 | 5.9 |
| 3 | Water Circulation Loops | Loop Temperatures above 40 degrees are not required. Buried circulating mains are in good condition and consequently have very little heat loss, there is negligible advantage heating these lines to 48 degrees which comes at a substantial cost. Loop two requires a chlorine makeup injection port; currently chlorine residual is being controlled by dumping 2,000 gallons of water/week to waste. With these savings and the implementation of recovered heat from the MKEC power plant, heating fuel requirements should be reduced to those of facility heat. | \$5,370 | \$105,000 | 1.09 | 19.6 |

Table 4.1
Chuathbaluk Water Treatment Plant, Chuathbaluk, Alaska
PRIORITY LIST – ENERGY EFFICIENCY MEASURES

| Rank | Feature | Improvement Description | Annual Energy Savings | Installed Cost | Savings to Investment Ratio, SIR | Simple Payback (Years) |
|----------------------------|-----------------------------------|---|-----------------------|------------------|----------------------------------|------------------------|
| 4 | Water Storage Tank | The water storage tank receives water from the well pump and heats it to 50 degrees. The turnover in the tank is very high, and the thermal storage capacity of the water is also high, so the tank should only be heated to 40 degrees. Implement waste heat from the MKEC power plant to heat storage tank. | \$1,981 | \$40,000 | 1.05 | 20.2 |
| 5 | Setback Thermostat: Chemical Room | Implement a Heating Temperature Unoccupied Setback to 45.0 deg F for the Chemical Room space. | \$38 | \$500 | 1.02 | 13.2 |
| TOTAL, all measures | | | \$8,597 | \$150,700 | 1.16 | 17.5 |

4.2 Interactive Effects of Projects

The savings for a particular measure are calculated assuming all recommended EEMs coming before that measure in the list are implemented. If some EEMs are not implemented, savings for the remaining EEMs will be affected. For example, if ceiling insulation is not added, then savings from a project to replace the heating system will be increased, because the heating system for the building supplies a larger load.

In general, all projects are evaluated sequentially so energy savings associated with one EEM would not also be attributed to another EEM. By modeling the recommended project sequentially, the analysis accounts for interactive affects among the EEMs and does not “double count” savings.

Interior lighting, plug loads, facility equipment, and occupants generate heat within the building. When the building is in cooling mode, these items contribute to the overall cooling demands of the building; therefore, lighting efficiency improvements will reduce cooling requirements in air-conditioned buildings. Conversely, lighting-efficiency improvements are anticipated to slightly increase heating requirements. Heating penalties and cooling benefits were included in the lighting project analysis.

4.3 Mechanical Equipment Measures

4.3.1 Heating/ Domestic Hot Water Measure

| Rank | Recommendation | | | | |
|---|--|--|-----|-----------------------------|-------|
| 2 | Clean and tune boilers, add in two primary loops on the boilers to control them individually and isolate one boiler. | | | | |
| Installation Cost | \$5,000 | Estimated Life of Measure (yrs) | 20 | Energy Savings (/yr) | \$849 |
| Breakeven Cost | \$12,776 | Savings-to-Investment Ratio | 2.6 | Simple Payback yrs | 6 |
| Auditors Notes: Using a primary loop for each boiler, and then being able to valve one boiler off without disrupting the system would increase heating efficiency and reduce losses through the un used boiler. Boilers should be cleaned and tuned yearly to improve efficiency. | | | | | |

4.3.2 Night Setback Thermostat Measures

| Rank | Building Space | Recommendation | | | |
|---|----------------|---|------|-----------------------------|-------|
| 1 | Water Plant | Implement a Heating Temperature Unoccupied Setback to 50.0 deg F for the Water Plant space. | | | |
| Installation Cost | \$200 | Estimated Life of Measure (yrs) | 15 | Energy Savings (/yr) | \$358 |
| Breakeven Cost | \$4,859 | Savings-to-Investment Ratio | 24.3 | Simple Payback yrs | 1 |
| Auditors Notes: The water plant should be set to be heated to only 50 degrees when the facility is unoccupied. Since the water plant rarely is occupied, this will reduce the heating demand of the facility significantly and reduce heating demand. | | | | | |

| Rank | Building Space | Recommendation | | | |
|--|----------------|---|-----|-----------------------------|------|
| 5 | Chemical Room | Implement a Heating Temperature Unoccupied Setback to 45.0 deg F for the Chemical Room space. | | | |
| Installation Cost | \$500 | Estimated Life of Measure (yrs) | 15 | Energy Savings (/yr) | \$38 |
| Breakeven Cost | \$512 | Savings-to-Investment Ratio | 1.0 | Simple Payback yrs | 13 |
| Auditors Notes: Currently a thermostat in the chlorine room is controlling only the fan in the unit heater. The room is being overheated by the coil in the unit heater that is running uncontrolled. A zone valve should be installed so that the unit heater fan and the coil respond to the thermostat, and the room can be maintained at 45 degrees. | | | | | |

4.4 Electrical & Process Measures

4.4.1 Water Storage Tank Measures

| Rank | Location | Description of Existing | Efficiency Recommendation | | |
|--|----------|--|---|-----------------------------|---------|
| 4 | | | The water storage tank receives water from the well pump and heats it to 50 degrees. The turnover in the tank is very high, and the thermal storage capacity of the water is also high, so the tank should only be heated to 40 degrees. Implement waste heat from the MKEC power plant to heat storage tank. | | |
| Installation Cost | \$40,000 | Estimated Life of Measure (yrs) | 25 | Energy Savings (/yr) | \$1,981 |
| Breakeven Cost | \$41,955 | Savings-to-Investment Ratio | 1.0 | Simple Payback yrs | 20 |
| Auditors Notes: A recovered heat system is feasible in Chuathbaluk. Circulation line number two runs adjacent to the power plant and returns directly to the water plant, without service connections on the length. This will allow generated heat that is currently radiated to air to be transferred through heat exchangers directly to the circulating water main. This heated line can then transfer heat to the other water circulation loops and water storage tank. This project with cross flow of circulating mains would also eliminate the need for chlorine makeup or dumping loop two water. Recovered heat would satisfy all process loads in this facility. | | | | | |

4.4.2 Water Circulation Loop Measures

| Rank | Location | Description of Existing | Efficiency Recommendation | | |
|--|-----------|--|--|-----------------------------|---------|
| 3 | | | Loop Temperatures above 40 degrees are not required. Buried circulating mains are in good condition and consequently have very little heat loss, there is negligible advantage heating these lines to 48 degrees which comes at a substantial cost. Loop two requires a chlorine makeup injection port; currently chlorine residual is being controlled by dumping 2,000 gallons of water/week to waste. With these savings and the implementation of recovered heat from the MKEC power plant, heating fuel requirements should be reduced to those of facility heat. | | |
| Installation Cost | \$105,000 | Estimated Life of Measure (yrs) | 25 | Energy Savings (/yr) | \$5,370 |
| Breakeven Cost | \$114,033 | Savings-to-Investment Ratio | 1.1 | Simple Payback yrs | 20 |
| Auditors Notes: A recovered heat system is feasible in Chuathbaluk. Circulation line number two runs adjacent to the power plant and returns directly to the water plant, without service connections on the length. This will allow generated heat that is currently radiated to air to be transferred through heat exchangers directly to the circulating water main. This heated line can then transfer heat to the other water circulation loops and water storage tank. This project with cross flow of circulating mains would also eliminate the need for chlorine makeup or dumping loop two water. Recovered heat would satisfy all process loads in this facility. | | | | | |

5. ENERGY EFFICIENCY ACTION PLAN

Through inspection of the energy-using equipment on-site and discussions with site facilities personnel, this energy audit has identified several energy-saving measures. The measures will reduce the amount of fuel burned and electricity used at the site. The projects will not degrade the performance of the building and, in some cases, will improve it.

Several types of EEMs can be implemented immediately by building staff, and others will require various amounts of lead time for engineering and equipment acquisition. In some cases, there are logical advantages to implementing EEMs concurrently. For example, if the same electrical contractor is used to install both lighting equipment and motors, implementation of these measures should be scheduled to occur simultaneously.

Appendix A – Listing of Energy Conservation and Renewable Energy Websites

Lighting

Illumination Engineering Society - <http://www.iesna.org/>

Energy Star Compact Fluorescent Lighting Program - www.energystar.gov/index.cfm?c=cfls.pr_cfls

DOE Solid State Lighting Program - <http://www1.eere.energy.gov/buildings/ssl/>

DOE office of Energy Efficiency and Renewable Energy - http://apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?c=lighting.pr_lighting

Hot Water Heaters

Heat Pump Water Heaters -

http://apps1.eere.energy.gov/consumer/your_home/water_heating/index.cfm/mytopic=12840

Solar Water Heating

FEMP Federal Technology Alerts – http://www.eere.energy.gov/femp/pdfs/FTA_solwat_heat.pdf

Solar Radiation Data Manual – <http://rredc.nrel.gov/solar/pubs/redbook>

Plug Loads

DOE office of Energy Efficiency and Renewable Energy – http://apps1.eere.energy.gov/consumer/your_workplace/

Energy Star – http://www.energystar.gov/index.cfm?fuseaction=find_a_product

The Greenest Desktop Computers of 2008 - <http://www.metaefficient.com/computers/the-greenest-pcs-of-2008.html>

Wind

AWEA Web Site – <http://www.awea.org>

National Wind Coordinating Collaborative – <http://www.nationalwind.org>

Utility Wind Interest Group site: <http://www.uwig.org>

WPA Web Site – <http://www.windpoweringamerica.gov>

Homepower Web Site: <http://homepower.com>

Windustry Project: <http://www.windustry.com>

Solar

NREL – <http://www.nrel.gov/rredc/>

Firstlook – <http://firstlook.3tiergroup.com>

TMY or Weather Data – http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/

State and Utility Incentives and Utility Policies - <http://www.dsireusa.org>